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Wireless Technology and Spectrum Demand: Advanced Wireless Services

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Summary

Advances in wireless telecommunications technology are converging with Internet technology to foster new generations of applications and services. Presently, the United States and other countries are moving to third-generation (3G) and fourth-generation mobile telephony. The defining feature of these technologies is that transmission speeds are significantly faster than prevailing technology, making it possible to provide services such as high speed access to the Internet and receive broadcast television programs.

A related trend is the growth in use of Wi-Fi (wireless fidelity) and WiMAX (an industry designation for a specific broadband standard). Wi-Fi uses local wireless networks for high-speed access to the Internet. WiMAX has a broader range of distance. 3G could be described as bringing Internet capabilities to wireless mobile phones; Wi-Fi as providing wireless Internet access for laptop computers; and WiMAX as expanding networks with wireless links to fixed locations. The technologies are seen by some as competing for customers and by others as complementary — providing a broader base and greater choice of devices for wireless communications and networking. From the perspective of spectrum management, a significant difference in the technologies is that 3G and WiMAX services operate on designated, licensed frequencies, while Wi-Fi shares unlicenced spectrum with other technologies. Providers of the two technologies share in common the concern that there is insufficient spectrum available for their services to be developed to full market potential. As the markets for Wi-Fi and WiMAX develop, wireless carriers have become concerned about the competitive impact on their businesses when municipalities offer wireless broadband services. Responding to lobbing efforts by telecommunications companies, several states have passed laws prohibiting or limiting local governments' ability to provide broadband service to residents. In the 109th Congress a bill to restrict municipal communications services, H.R. 2726 (Representative Sessions), and a bill that would guarantee the right of local governments to provide advanced communications services (S. 1294, Senator Lautenberg) have been introduced.

This report will be updated.

Wireless Technology: Development and Demand

In order to deploy advanced wireless technologies, telecommunications carriers, network operators, and their suppliers are seeking effective strategies to move to new standards, upgrade infrastructure, and develop software for new services. This migration path includes decisions about using spectrum.

Radio frequency (RF) spectrum is used for all wireless communications. It is managed by the Federal Communications Commission (FCC) for commercial and other non-federal uses and by the National Telecommunications and Information Administration (NTIA) for federal government use. International use is facilitated by numerous bilateral and multilateral agreements covering many aspects of usage, including mobile telephony. Spectrum is segmented into bands of radio frequencies and typically measured in cycles per second, or hertz.[1]

Spectrum bandwidth is a finite resource that is infinitely re-usable. Commercial wireless communications currently rely on bandwidth within a narrow range.[2] American competitiveness in advanced wireless technology may be constrained by the limited amount of exploitable bandwidth that is available. This constraint is both specific, in the inherent finiteness of useful spectrum, and relative, in comparison to the amount of spectrum available for commercial use in other countries. Developments in technology have in the past facilitated the more efficient use of bandwidth within a given portion of the spectrum. New technologies, such as Software-Defined Radio (SDR) and "smart" antennae for terrestrial wireless, are being explored and implemented to increase the efficiency of spectrum and to expand its usable range.

Mobile Telephony. Mobile communications became generally available to businesses and consumers in the 1980s. This "first generation" technology, still in use, is analog, the prevailing telecommunications technology of the time. Second generation (2G) wireless devices are characterized by digitized delivery systems that provide qualitatively better delivery of voice and small amounts of data, such as caller ID. The next major advance in mobile technology is referred to as the third generation (3G) because it represents significant advances over the analog and digital services that characterize current cellular phone technology. A dramatic increase in communications speed is the most important technical feature of 3G.[3] Fourth-generation (4G) networks are expected to deliver wireless connectivity at speeds up to 20 times faster than 3G..

Wireless communications services have grown significantly worldwide, and explosively in some countries. Consumer demand for wireless telephony in the United

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[1] One million hertz = 1 megahertz (MHZ); 1 billion hertz = 1 gigahertz (GHz).

[2] The FCC limits consideration of bandwidth available for 3G to frequencies below 3 GHz.

[3] The Federal Communications Commission (FCC) identifies key service attributes and capabilities of 3G as the following: capability to support circuit and packet data at high bit rates; interoperability and roaming; common billing and user profiles; capability to determine and report geographic position of mobiles; support of multimedia services; and capabilities such as "bandwidth on demand." 3G speeds are: 144 kilobits per second at vehicular traffic speeds; 384 kilobits for pedestrian traffic; 2 megabits or higher for indoor traffic, [http://www.fcc.gov/3G]. Viewed June 8, 2005.

States has soared in recent years, totaling over 190 million mobile phone subscribers in June 2004.[4] In approximately the same time frame, use of the Internet expanded dramatically from an arcane tool for specialized research to a popularized, user-friendly service providing near instant access to information and entertainment. Wireless Internet is widely expected to redefine how computers are used in the future. 3G technologies bring the wireless Internet revolution to cell phones. Business and consumer demand for new, advanced wireless services — including 3G and Local Area Networks (LANS), such as those using Wi-Fi (wireless fidelity) — is considered by many to be an engine for future growth in American and global economies.

Third-generation and future developments in wireless technology will be able to support many services for business and consumer markets, such as: enhanced Internet links, digital television and radio broadcast reception, high-quality streaming video, and mobile commerce (m-commerce) — including the ability to make payments

Wi-Fi and WiMAX. Wireless Local Area Networks (W-LANs) operate on unlicenced spectrum, using radio frequencies in the free 2.4 GHz and 5.4/5.7GHz spectrum bands. A group of standards for frequency use in these bands is known as the 802.11 family. The 802.11b standard is currently the most widely used and is commonly referred to as Wi-Fi, for wireless fidelity. Wi-Fi provides high-speed Internet access for personal computers and Personal Digital Assistants (PDAs) and is also widely used by businesses to link computer-based communications within a local area. Links are connected to a high-speed wireline (landline) either at a business location or through HotSpots. HotSpots are typically located in homes or convenient public locations, including many airports and café environments such as Starbucks. Another standard for wireless Internet is Bluetooth, which has a shorter range than Wi-Fi but works well in cell phones. Bluetooth handles both voice and data; Wi-Fi is mostly data but also supports Voice over Internet protocol (VoIP) calls, sometimes known as VoWiFi.

WiMAX refers to an industry coalition of network and equipment suppliers[5] that have agreed to develop interoperable broadband wireless based on a common standard (IEEE 802.16). It can transmit data over distances of up to 30 miles and is being tested in the United States as a “last mile” technology, that is, a means to provide fixed wireless service to locations that are not connected to networks by cable or high-speed wires. WiMAX uses multiple frequencies around the world, an impediment to interoperability. In the United States, the 700 MHZ band is being used in some WiMAX deployments and there is industry interest in expanding to other 700 MHZ frequencies to create national access. Much of the 700 MHz spectrum is currently blocked by the broadcasting industry, which uses these frequencies for analog television broadcasts. The anticipated transition to digital broadcasting would free this spectrum, possibly making it available for WiMAX applications.

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[4] Statistic updated regularly at [http://www.ctia.org].

[5] Founding members of the WiMAX forum include Airspan, Alvarion, Analog Devices, Aperto Networks, Ensemble Communications, Fujitsu, Intel, Nokia, Proxim, and Wi-LAN.

Municipal Deployment of Broadband

The Telecommunications Act of 1996 was intended, among other purposes, to foster and encourage competition among providers of telecommunications services. In the act, Congress barred states from "prohibiting the ability of any entity to provide any interstate or intrastate telecommunications service."[6] Some states have in recent years passed laws that prohibit or limit local governments from providing telecommunications services. An effort to challenge such a law in Missouri by municipalities offering local communications services in the state was heard before the U.S. Supreme Court in 2004.[7] The Court ruled that "entity" was not specific enough to include state political divisions. If Congress wished to specifically protect both public and private entities, they could do so by amending the language of the law. This decision and the steady improvement in broadband communications technologies that municipalities wish to have available in their communities, have provided fuel for a policy debate about access to broadband services. The central debate is whether municipal broadband services are part of essential infrastructure — like electrical power or water — with many benefits, including stimulus to the local economy, or whether they provide unfair competition that distorts the marketplace and discourages commercial companies from investing in broadband technologies.

The two main broadband technologies that are particularly attractive to communities, in part because they support existing community services such as Internet access for schools and communications for public safety, are fiber-optic-based networks and wireless access — WiFi today, possible WiMAX in the future. The spread of wireless services such as access to the Internet and anticipated advances in wireless technology are modifying the business case for broadband. Networks that depend on a fiber-optic cable backbone are capital-intensive and usually most profitable in high-density urban areas. A number of rural communities have used their resources to install fiber-optic broadband services in part because they were too small a market to interest for-profit companies. The technology for Wi-Fi today costs less and has a wider geographic reach, broadening the size of potential markets for broadband. Therefore, although the arguments pro and con about the municipal provision of broadband applies generally to all types of broadband services, it is the long-term profit potential of Wi-Fi and its successor technologies that are apparently spurring commercial wireless service providers to lobby against municipal competition. In particular, the fact that urban areas are creating Wi-Fi networks and providing, among other services, free access to HotSpots (wireless links to the Internet) is viewed as a threat to commercial companies and a form of unfair competition. Municipalities around the world have installed free Wi-Fi zones, including New York and Chicago; one is planned for the entire city of Philadelphia The cities argue that generally available access to the Internet through wireless connections has become an urban amenity, arguably a necessity in sustaining and developing the local economy. Municipal Wi-Fi also provides the opportunity to improve social services and Internet access in disadvantaged communities that often are not served by fiber optic networks.

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[6] 47 U.S.C. 253 (a).

[7] U.S. Supreme Court, Docket Number 02-1238.

The fierce debate around public-sector provision of what some consider to be a private-sector service is expected to continue. Increasingly, Congress can expect pressure from advocates from both sides to clarify the language of Section 243 or to take some other action that addresses the issue.

Policy Considerations in the 109th Congress

The continued growth in demand for bandwidth for private and public sector use is one of the factors prompting Congress to review the policies and laws that guide the allocation and management of spectrum. Areas of debate include the role of auctions in allocating spectrum,[8] the transition to digital television,[9] and the availability of spectrum to support public safety communications and interoperability.[10] It is possible that these issues will conflate and be treated together in a single bill or be included in various other initiatives for telecommunications reform under consideration by the 109th Congress. Current bills include the Preserving Innovation in Telecom Act (H.R. 2726, Representative Sessions) and the Community Broadband Act of 2005 (S. 1294, Senator Lautenberg). The House bill would amend the Communications Act of 1934 to prohibit states and local governments from providing telecommunications, information services, or cable in any geographic area in which a similar service is offered by a private sector company. The Senate bill would amend the Communications Act to specifically permit local governments to provide advanced telecommunications access.

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[8] See CRS Report RL31764, *Spectrum Management: Auctions* and CRS Report RS21508, Spectrum *Management and Special Funds*.

[9] See CRS Report RL32622, *Public Safety, Interoperability and the Transition to Digital Television*.

[10] See CRS Report RL32594, *Public Safety Communications: Policy, Proposals, Legislation and Progress*.